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ITEM OF INTEREST

Prepared by

Aerospace Information Division

SUBJECT: Ferrite Measurements

SOURCE: Kugayevskiy, A. F. Determination of complex magnetic permeability of ferrites in the meter-wave range. Izmeritel'naya teknika, no. 2, Feb 1962, 53-55. (S/115/62/000/002)

A variation of the impedance measurement method as applied to measuring complex magnetic permeability of ferrites in the meter-wave band is discussed. It has been proposed to use ferrite specimens of toroidal shape inserted into a coaxial waveguide as shown in Fig. 1.

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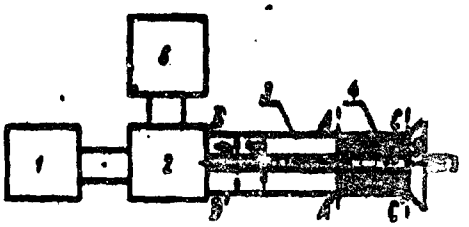

Fig. 1.

1 - Oscillator of nonmodulated signals; 2 - admittance or impedance meter; 3 - coaxial line section; 4 - specimen under test; 5 - plunger; 6 - receiver.

Both the complex magnetic permeability μ^* and the loss-angle tangent $\operatorname{tg}\delta_\mu$ are determined by formulas obtained on the basis of calculating transmission-line impedance according to the

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general transmission line theory:

$$\mu^* = \mu' - j\mu''$$

$$\operatorname{tg} \delta_\mu = \frac{\mu''}{\mu'} .$$

The method requires that the real and the imaginary parts of the line impedance be known in order to use the following formulas for determining μ'' and μ':

$$\mu'' = \frac{R_{in}}{Z_c \beta_e d} ,$$

$$\mu' - 1 = \frac{X_{in}}{Z_e \beta_e d} ,$$

where Z_e is the impedance of the coaxial line in the absence of a specimen, $\beta_e = 2\pi/\lambda$ and d, the thickness of a ferrite specimen. The terms X_{in} and R_{in} can be determined experimentally according to procedures described in the article. Impedance measurements are performed by means of a separate ИПП-1 impedance meter with a 250-mc range and measuring errors of 0.5-1%. Attention is called to the necessity of providing a tight contact between the specimen and the waveguide walls.

COMMENT:

The development of ferrites with desired characteristics requires finding a convenient method for measuring their complex permeabilities. The many methods known for this purpose are variations of the classical method introduced by J. B. Birks [Physical Society, London. Proceedings, 60, part 3, 282-292 (1948)].

However, all known methods are not directly applicable to measuring "lossy" ferrites, i.e., those of finite thickness producing losses of electromagnetic energy of the order of tens of db/cm at higher frequencies. The development of a method for reliable measurement of the parameters of lossy ferrites would be of a great practical importance, particularly for research concerned with obtaining ferrites of the desired absorption characteristics. However, there are still great difficulties in this respect due to the inapplicability of Birks' classical formulas to the case of lossy ferrites.

It is interesting to note that Soviet scientists apparently are not yet in possession of techniques permitting the

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measurement of complex ferrite parameters without reservations in respect to the required limitation of their thickness. An assumption introduced into their mathematical transformations --

$$\tan h\gamma_g d = \gamma_g d \quad \text{and} \quad \tan h\gamma_0 d = \gamma_0 d,$$

where γ_g and γ_0 are propagation constants-- can be applied with a sufficient degree of accuracy only when ferrite thickness d is small.

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